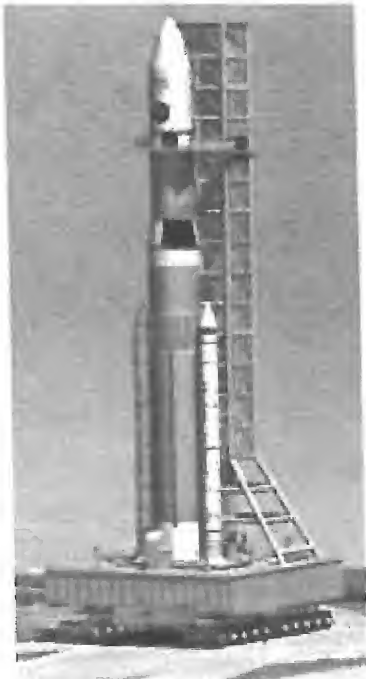




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Constellation Commodities Studies Summary



Presented to:
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Constellation Program

- ◆ (was) NASA's long-term program for space exploration
- ◆ Heavy-lift Ares V rocket was planned to have LH2 tanks about 2x the volume of the Shuttle.
 - LH2 losses during loading and scrub would likewise increase
 - Requirement to support 5 launch attempts in 5 days
 - 5x loading and scrub losses

Simply increasing the capacities of legacy methods will magnify inefficiencies/losses to gross levels



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CxP Studies

◆ Goal

- Solicit industry expertise in production, storage, and transportation required for future use
- Improve efficiency and life cycle cost over legacy methods

◆ Objectives

- Consolidate KSC, CCAFS and other requirements
- Extract available industry expertise
- Identify commercial opportunities
- Synergy with State of Florida partnerships



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What We Already Knew

◆ Improve the System

- Priority:
 - Reduce Losses
 - Losses that cannot be eliminated; capture and reuse
 - Improve efficiency of Supply
 - Improve Storage
- Interdependence of Parameters
 - Example;
for a given launch campaign; reduced vehicle loading losses
reduces the required pad storage and required supply, which results
in reduced storage and delivery losses



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Results (what industry told us)

- ◆ Challenging requirements
 - Launch campaigns and associated losses cause a large difference between high short-term demand versus long-term average
 - Direct opposition to steady-state 24/7 production
 - Large cryogenic storage tanks required to handle short-term requirements
 - Access restrictions and narrow delivery time windows
- ◆ Constructing on-site industry standard production plants, storage tanks and purchasing standard distribution equipment could save money over long-term.
- ◆ No cost cutting or efficiency improving technologies were identified or proposed.
- ◆ Several supply architectures compared; no clear winner



Results (cont'd)

◆ Lessons learned

- “Tight lipped” industrial gas companies
 - Little information on make-or-buy decision
 - Withhold details as proprietary until bidding on a funded project
- Industry logistics optimized for typical customers, not space launch customers
 - No new technologies revealed
- Future requirements too uncertain

◆ “Game changing” concept

- Polygeneration by a Public Utility Authority
- Utility would produce and deliver LH2, LN2, LO2, and electrical power